TECHNOLOGY THROUGH A CONSTRUCTIVIST APPROACH

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Abstract

This paper describes a number of constructivist learning theories and illustrates how these theories underpin one significant task undertaken by students in a primary teacher-education degree programme. The activity aims to develop students' understanding of technological practice and theory and to help them determine how they can bring these understandings to the primary classroom. By involving students in a collaborative and cooperative activity where they need to develop a technological solution, reflect on theirs and others technological processes and make explicit links to literature on authentic technological practice, the students are able to construct understanding and knowledge, not only of technological practice in the real world but how this can be adapted and taught in the primary classroom.

INTRODUCTION

The *New Zealand Curriculum: Draft for Consultation 2006* , recently released to schools, provides a clear directive for teachers to encourage students to work cooperatively and collaboratively with others and to be involved in managing their own learning. This paper, in documenting an activity used within a primary teacher education programme, discusses how learning theory relevant to technology education and to technology teacher education can intersect to meet the Ministry directive within the context of an evolving technology curriculum. On the premise that any such

discussion must consider principles of sound education,[1] the paper also discusses the theoretical underpinnings of such practice, and attempts to demonstrate that it is possible to apply and model sound education theories within both the primary classroom and teacher education.

BACKGROUND TO THE ACTIVITY

The activity referred to in this paper is a collaborative, cooperative task completed as part of the course, 'Experiencing Technology Education (TE 261)'. This activity, in turn, is part of the three-year Bachelor of Teaching and Learning degree for primary-level (children 5 to 13 years of age) currently offered to pre-service teacher education students at the Christchurch College of Education[2], Christchurch, New Zealand. The course involves 20 hours of face-to-face class time and 30 hours of independent study, and students take it in their final year of study. To meet the learning outcomes of the course relevant to this paper, students must:

- compare, analyse and appraise the nature of technological practice in different technological communities
- explore and analyse underlying technological principles and examine and appraise complex systems in terms of how they are linked
- identify a technology unit of work which meets the requirements of the technology curriculum and the place of critical reflection in the design of technology units of work
- demonstrate their own technological capability, document and use this, with their own technological knowledge, to further their understanding of the holistic and integral nature of technology in the primary classroom
- participate in, analyse and appraise the nature of technological practice in the primary classroom (Fox-Turnbull & Haynes, 2003).

[1] The author firmly believes that all students from early childhood to tertiary deserve the right to education based on sound current education theory.

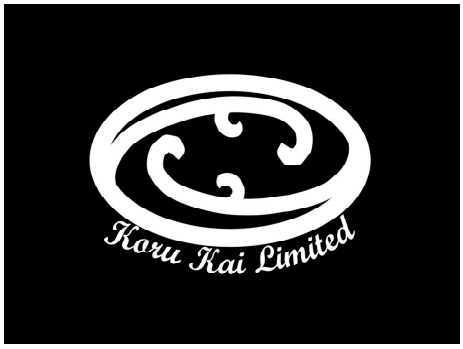
[2] As from January 1 2007 the Christchurch College of Education merged with neighbouring University of Canterbury and is now known as the University of Canterbury College of Education.

Classes in the School of Primary Teacher Education typically have 30 to 35 adult students from a range of ages and backgrounds. Course content covers a mix of theory and practice. To complete this course the students have one two hour lecture per week for a period of ten weeks. The course includes a number of different learning activities, each grounded in constructionist theory, one of which is used in this paper to illustrate how constructivist theory can be applied to teacher education. Lectures take place in a specialist room which includes seven hexagonal tables with chairs for written and group work, a food preparation area with two ovens and general cooking facilities and equipment and a 'workshop' area which includes a range of tools and equipment. The room represents facilities that are likely to be found in a primary or intermediate specialist technology facility in New Zealand schools.

THE IMMIGRANT BISCUIT ACTIVITY

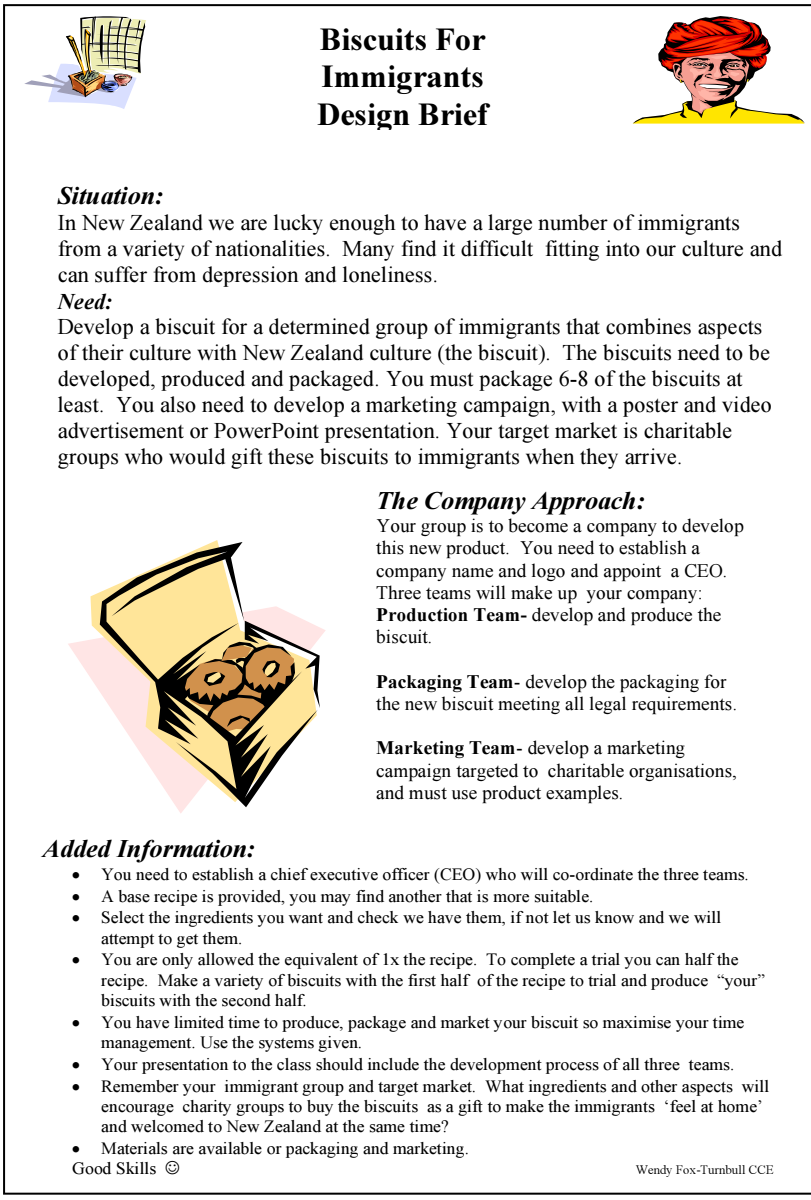
The activity described in this paper has been developed in a constructivist paradigm, it is used to illustrate how a constructivist approach can be used in tertiary teacher education and is predicated on the understanding that students' practice must be as close as practicable to authentic technological practice (Turnbull, 2002). It requires students to develop and market a packaged biscuit that could be given as a gift to an immigrant group, welcoming them to New Zealand and at the same time giving them a nostalgic feel of home. The packages must meet legal food labelling and packaging requirements. The target market groups for the packaged biscuits are charitable organisations that gift the biscuits to immigrants. Students are required to complete this activity in a culturally sensitive manner and are directed to thoroughly research their immigrant group to avoid any stereotypes.

Example 1: A selection of slides from a marketing PowerPoint to welcome immigrants from Hungary



The students work in teams, within their class cohort, using a mock company approach. This activity occurs over the first five weeks of the course. Students are given approximately half of the allocated class time to work independently within their groups. The activity culminates with a presentation to the group by each 'marketing' team. All students are required to record their individual technological practice in a portfolio which is handed in for assessment purposes. The assignment represents 50% of the course assessment. Figure 1 is a copy of the brief given to the students.

Figure 1: Brief given to the students for the activity 'immigrant biscuit'



Biscuits For Immigrants Design Brief

Situation:
In New Zealand we are lucky enough to have a large number of immigrants from a variety of nationalities. Many find it difficult fitting into our culture and can suffer from depression and loneliness.

Need:
Develop a biscuit for a determined group of immigrants that combines aspects of their culture with New Zealand culture (the biscuit). The biscuits need to be developed, produced and packaged. You must package 6-8 of the biscuits at least. You also need to develop a marketing campaign, with a poster and video advertisement or PowerPoint presentation. Your target market is charitable groups who would gift these biscuits to immigrants when they arrive.

The Company Approach:
Your group is to become a company to develop this new product. You need to establish a company name and logo and appoint a CEO. Three teams will make up your company:
Production Team- develop and produce the biscuit.

Packaging Team- develop the packaging for the new biscuit meeting all legal requirements.

Marketing Team- develop a marketing campaign targeted to charitable organisations, and must use product examples.

Added Information:

- You need to establish a chief executive officer (CEO) who will co-ordinate the three teams.
- A base recipe is provided, you may find another that is more suitable.
- Select the ingredients you want and check we have them, if not let us know and we will attempt to get them.
- You are only allowed the equivalent of 1x the recipe. To complete a trial you can half the recipe. Make a variety of biscuits with the first half of the recipe to trial and produce "your" biscuits with the second half.
- You have limited time to produce, package and market your biscuit so maximise your time management. Use the systems given.
- Your presentation to the class should include the development process of all three teams.
- Remember your immigrant group and target market. What ingredients and other aspects will encourage charity groups to buy the biscuits as a gift to make the immigrants 'feel at home' and welcomed to New Zealand at the same time?
- Materials are available or packaging and marketing.

Good Skills ☺

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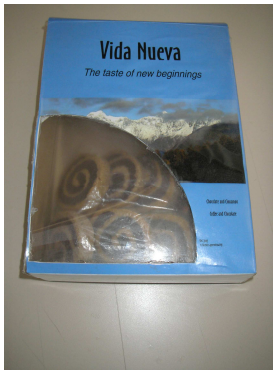
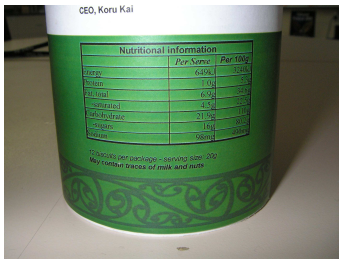
The immigrant biscuit activity fits into the strand 'technological practice' as set out in the *New Zealand Curriculum Draft for consultation 2006* (Ministry of Education, 2006). It engages the students in two components of practice-'planning for practice' and 'outcome development and evaluation' and it is identified in the 'technological practice' strand proposed in the draft New Zealand Curriculum document (Ministry of Education, 2006). This strand requires students to plan (in detail) and implement their own technological practice within the broader aim of developing and evaluating a specific technological outcome.

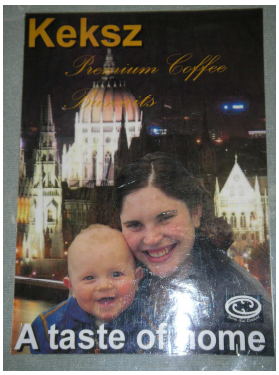
Example 2: An example of a biscuit and its package produced by the student teachers doing the immigrant biscuit activity



Other purposes of the biscuit activity are to introduce and model 'the company approach' to student-teachers and to give them opportunity to work in a situation that requires cooperation and collaboration in order to meet identified needs, as stated in *Technology in the New Zealand Curriculum* (Ministry of Education, 1995, p. 16). It is this notion of learning through participation and collaborative thinking processes that is the root of apprenticeship and underpins the practice of many modern production companies (Daniels, 1996; Hennessy, 1993). The level of cooperation and coordination required for this activity is clearly illustrated in Examples 1 and 3. The packaging team needed to liaise with the marketing team about the logo and colours used and the production team needed to get an accurate list of ingredients to produce a nutritional information panel (see second photo) using the Australia New Zealand Food Standards Authority (ANZFA) nutritional panel calculator. Production team needed to complete the biscuit so that the packaging team could use it on their label and the marketing team needed to understand the 'flavour' of the biscuit and package so that they could accurately represent the product in their advertising Powerpoint.

Example 3: The biscuit package, nutritional information panel and an advertising poster for the biscuit to welcome Hungarian immigrants





The activity allows modelling of an experience that student-teachers can use directly or modified for use in the primary classroom. It further allows them to experience the authentic technological practices of planning for practice and product development (biscuit, package and marketing campaign) and to engage in reflective practice in terms of making links between theories of social constructive ways of learning, theories of technological practice and their own learning within technological practice. During the activity, the students are taught task and time-management strategies, and they also experience the use of the portfolio as an assessment tool within technology activities.

The company approach requires the course lecturer to assign each member of the class to one of two competing companies. The lecturer does this through an alternate alphabetical approach. Once in their company, the students are 'given' a specific immigrant group and asked to appoint a chief executive officer (CEO). The CEO facilitates the division of the company into three teams- production, packaging, and marketing. Teams work together to develop the biscuit, its packaging and a marketing PowerPoint or video that advertises the product. The division into teams is usually done so that students are working in an area of interest which increases motivation and given the tight time frames students are working in

makes most efficient use of time. This model has been used successfully within a Year 5-7 (ages 9-11) primary classroom by the researcher. In the primary classroom teachers need to consider carefully whether children are working to their areas of strengths, it may be advantageous to challenge children by getting them working in unfamiliar areas. The emphasis is on teamwork, collaboration and cooperation. The researcher, as lecturer, has observed a relationship between the quality of the developed outcome and the quality of relationships within each team and across the whole company. Working with adults there is little need for or time to teach collaboration and cooperation skills and techniques but when working with children these skills are necessary prerequisites.

Through experience, observation and anecdotal evidence, the course lecturer (author of this paper) determines that the company approach is particularly useful in allowing students to work on quite different technology-related areas within the same project. This of course can cause difficulties in teaching a wide variety of skills, knowledge and processes and with assessment especially when focussed on skill and product. However this can be successfully managed with careful planning of skills sessions and assessment that focuses on process rather than product. Teaching skills and knowledge to small groups of children / students as they determine a need for them is motivating and makes learning meaningful and authentic (Hennessy, 1993). An example of teaching a skill to meet a specific need is illustrated in Example 4. The packaging team wanted to protect the biscuits and stop them sliding when inside the box. After some discussion and experimentation they elected to develop a tray using the vacuum forming process. At this point the "teacher" took a skills session teaching the students to safety use the vacuum former to and to develop suitable patterns.

Example 4: Biscuits inside a plastic vacuum formed tray

RELEVANT SOCIO-CULTURAL CONSTRUCTIVIST THEORY

The acquisition of technological knowledge accords with several socio-cultural/constructionist theories of knowing. Constructivist theories (and theorists) such as; Situated Cognition and Authenticity (Hennessy, 1993 and Bereiter, 1992), Scaffolding and Modelling (Bruner, 1996 and Vygotsky, 1978), Integrated Inquiry (Murdoch, 2004 and Blythe, 1998), Abstract to Concrete Theory **(**Engeström 1996, and Davydov, 1988) and Higher Order Thinking (deBono 1992) claim that people construct knowledge through interaction with others in the socio-cultural environment. As such, knowledge is socially constructed. In their discussion paper on the nature of technology, Compton and Jones (2004) state that technological knowledge is socially constructed. This is because the social and cultural values of particular groups of people influence the technological advances made at any one time. Technological activity accordingly is embedded in the 'made world' and is influenced by social, cultural, environmental, economic and political influences.

The relationship between societal and technological development is thus complex and inseparable (Compton & Jones, 2004). Hennessy (1993, p.11) clearly supports this notion: 'It is obvious that merely presenting children with new information and experiences in the classroom is insufficient to promote learning.' Within the context of technology education, giving students problems that allow them to work within a specific technological culture or practice motivates

them because they find it has direct and perceivable relevance to their work (Fox-Turnbull, 2006; Hennessy & Murphy, 1999). Similarly, when children are given opportunity to solve technological problems through use of activities and practices that are authentic to or mirror a specific culture of technological practice, their knowledge and understanding of practices and issues are likely to be stronger. This is because they are able, through activity and reflection, to make connections to real needs, issues and practice within society (Turnbull, 2002). The 'Immigrant Biscuit' is a case in point. The remainder of this paper examines this activity against several social-constructionist theories. Each theory begins with a brief description of it, and is followed by a reflective examination, on the part of the author, of relevance of the theory for the activity and of how well the activity meets the precepts of each theory.

EXAMINATION OF BISCUIT ACTIVITY AGAINST SELECTED THEORIES

A. Situated Cognition and Authenticity

Situated cognition encompasses thinking as a part of a culturally organised activity carried out within a community of practitioners. Procedural and conceptual knowledge is an active part of this process (Bereiter, 1992). Cognitive apprenticeship methods of learning aim to enculturate students to *authentic* practices through activity and social interaction. Cognitive apprenticeship programmes develop students through situated learning, enabling students to observe, engage and invent or discover strategies in context (Hennessy, 1993) and facilitating the development of expert knowledge through the persistent solving of problems in relevant domains (Bereiter, 1992).

Turnbull (2002) argues that technology within the classroom needs to reflect authentic technological practice as much as is practical.

She determines that if children are to understand technological process, they must be actively engaged in practice that reflects the culture of real technological practice. The immigrant biscuit activity, while not totally authentic, is a valid approximation of a *technologically* authentic context for children. The *Christchurch Press* ("Join Together", 2006) recently reported a similar exercise completed by a group of Year 11 (15-16-years-old) students at a local secondary school, which led to the production of the 'Salam Biscuit' for the 'Unity Biscuit Company'. This biscuit is currently available in a number of cafes throughout the city and the developers hope it 'will come to symbolize Christian–Muslim unity.'

Hennessy (1993, p.15) reminds us that within our understandings of situated cognition, 'Learning is most successful when embedded in authentic and meaningful activity, making deliberate use of physical and social context' (Hennessy, 1993, p. 15). The Immigrant Biscuit activity meets this requirement. Throughout their technological practice, students are required to write detailed reflections in a portfolio, which clearly articulate and demonstrate the learning that is occurring during this activity. The Immigrant Biscuit activity encourages students to behave and act like technologists. Theories of situated cognition and cognitive apprenticeship (Hennessy, 1993) highlight the issue of the disjunction between traditional classroom learning and cognition in practice. This activity minimizes this disjunction by allowing the participants a freedom to discover new and exciting possibilities, often taking learning in unexpected directions and well beyond 'teacher' expectations, thus modelling real world technological practice.

Authenticity is also evident in that the student-teachers, before being able to teach children to model *authentic* technological practice, need to understand what technological practice looks, feels

and sounds like. An earlier 'technologist' assignment begins the facilitation of this process. In preparing for the biscuit activity and for a comprehensive understanding of authentic technological practice, the student-teachers, in their first technology education course, are required to identify a technologist from their community, interview them, observe and record their practice, then make explicit links between actual practice and the curriculum, models and definitions of technology practice. During the immigrant biscuit activity students continue to build their understanding of technological practice by being immersed into a technological practice. Primary children also working in a similar activity gain the same benefits.

B. Modelling and Scaffolding

In a constructivist approach, modelling and scaffolding are an integral approach to teaching and learning. The expert (teacher) begins by modelling the effective strategies and techniques and may make explicit their tacit knowledge. Scaffolding is the process whereby teachers guide learners through activity in a manner that gradually increases the confidence and competence of the learners (Hennessy, 1993). Bruner (1996) uses it as an umbrella term to describe a range of actions and strategies that an adult uses to help the children's learning efforts. The form of these supportive interventions vary but all aim to help the children gain goals that would be beyond them without the support. With gradual withdrawal of the scaffold, the learner becomes progressively independent.

Both these approaches relate to Vygotsky's (1978) notion of the 'zone of proximal development'. Within this zone, students and teachers engage in dialogue about knowledge students have and the knowledge students need. They also consider how the teachers, 'as experts', can assist and guide students in a manner that has the

teachers gradually withdrawing their support for students as they become more proficient at the task or learning at hand (McLachlan-Smith, 1998).

One example of scaffolding used in the immigrant biscuit activity is related to task and time management. These skills are a major part of any technological practice, whether involving a very simple craft activity or a complex industrial activity. Technologists manage their time, tasks and practice in various ways, and the biscuit activity builds in opportunity to engage in and consider these methods.

The immigrant biscuit activity requires the students to use and reflect on three different types of task and time management models. The first of these is a simple listing of the required tasks, identifying who is responsible for each one and determining when it needs to be completed. This in itself is a useful tool as it enables students and children to comprehend the scope of the activity. The other two methods are more complex in nature and are specifically taught using the modelling through scaffolding to independence method of teaching (Bruner, 1996). More specifically, in session three the students are introduced to the 'critical path' and 'herringbone timeline' models of management; they are modelled in class and fully explained in course notes. They are then presented with an exercise to help them work through the process of developing each model (scaffolding of the process) before they work through the process themselves on a provided template (moving towards independence). This theory and practice works particularly well as student teachers immediately see a need for and then use their new still. Within a primary classroom modelling and scaffolding theory works very successfully but only one time management method would be used at any one time, and must be carefully matched to the level and ability of the children.

Use of a template is a particularly useful scaffolding strategy within technology education. A template is a guide or pattern that guides the user towards the achievement of consistent outcomes. In the Immigrant Biscuit activity, the portfolio, in which students maintain a detailed record of their technological practice, is initially provided to the students in the form of a written template. This is to give the students structure and direction for their eventual writing. This has proved a very useful tool by very clearly setting out expectations and facilitates greater consistency across assignments submitted. Many students have modified their portfolio templates to use when teaching technology in the primary classroom. This indicates not only an increasing independence but also an ability to adapt and design solutions to meet individual needs.

C. Integrated Inquiry Learning

The inquiry approach reflects the belief that, for learners, active involvement in construction of their knowledge is essential for their effective learning (Murdoch, 2004). Inquiry is guided and systematic learning that proceeds through a number of teaching/learning phases. It is very different from 'open' discovery learning in that the teachers have a major and continuing responsibility to structure a range of activities sequenced to maximize the development of skills and thinking processes of the learners. Inquiry uses a wide range of teaching approaches from teachers' exposition to independent student research (Murdoch, 2004). Inquiry methodology and integrated curriculum are also supported by Caine and Caine (1990, cited in Murdoch, 2004). They argue that the brain seeks pattern, meaning and connectedness—methods that move from rote memorization to meaning-centred learning (Murdoch, 2004). Integrated inquiry learning involves students in developing deep learning through the process of self-motivated inquiry that strives towards development of 'big understandings' and 'rich concepts' (Murdoch, 2004) about the

world and how it functions (Blythe, 1998). Inquiry is centred on both process and content (Murdoch, 2004). New Zealand Inquiry learning is beginning used in a number of primary schools.

Quality technology-education programmes that use authentic learning offer an excellent model for inquiry-based learning because they allow integration of numerous curriculum areas. Compton and France (2006) recognize that technology is increasingly interdisciplinary and requires technologists to work in an integrated manner. Technology topics generally are 'vehicles' for learning from which students can engage in 'worthwhile exploration of meaningful content that relates to and extends … [their] life experiences and understanding of the world' (Murdoch & Hornsby, 2003, p 19). Within this sphere of learning, and within technology education, students also are given authentic opportunity to measure, speak, write reports, discuss and consider all manner of issues (e.g., social, health).

During the process of participating and learning in technology and technological concepts, other areas of the curriculum become more accessible (Lewis, 1999). Inquiry learning is clearly a teaching approach that lends itself to the authentic delivery of technology in the classroom. In a recent case study report on quality teaching in technology by the New Zealand Education Review Office (ERO), teachers in all case-study schools mentioned the value of authentic, real-life problems or situations selected for study (Education Review Office, 2006). One school specifically mentioned that students' inquiries and interests played a major role in directing learning.

The Immigrant Biscuit activity is a strong example of inquiry learning. The activity begins with a series of lessons that teach the student-teachers a range of skills they will need to conduct the activity. There is a clear structure and purpose to the learning, and

students also have the freedom to research and take their product in a number of different directions. The learning associated with the activity is also integrated with learning in a range of other disciplines, among them; social studies, visual and written English. This is illustrated in Example 5. The marketing team who developed these posters were involved in a number of inquiries in order to achieve their final outcome, a series of four posters, two of which are below, on continuous PowerPoint with nostalgic music to accompany and voice over about the product. These inquiries included such things as investigating Israeli culture to identify the difference between truth and stereotype; taking into consideration Māori protocol when sourcing and selecting suitable pictures and investigating potential possibilities when using PowerPoint i.e. layering pictures, incorporating voice over, adding music, adding text, inserting photos and locating and isolating a picture of a family.

Example 5: Two of the posters welcoming immigrants from Israel, note the different New Zealand backgrounds and the packaged biscuit in the foreground

D. Abstract to Concrete Theory

Another socio-cultural/constructivist theory relevant to the delivery of technology education is that of 'abstract to concrete theory', built on the premise that children's thinking ascends from the abstract to the concrete (Engeström, 1996). Engeström proposes that students analyse subject-matter content to identify the primary general relationships and then link new learning to other known contexts,

and from there to construct further abstract ideas related to the original subject-matter. Continuing analysis discloses rule-governed links between the original idea and its manifestations that, in turn, allow generalisations about the subject. Students use these generalisations to deduce more ideas, turning the primary mental formation into a concept that registers as a 'kernel' (growing idea or understanding) of the academic subject. This 'kernel' subsequently serves as a general principle whereby students can orient themselves in the entire multiplicity of factual curricular material they encounter, and which they continue to assimilate in conceptual form via an ongoing ascent from abstract to concrete. This process leads, for the student, to new types of theoretical concepts, theoretical thinking and consciousness. These theoretical concepts entail high-level metacognitive functions, such as reflections, analysis and planning.

The strategy of ascending from the abstract to the concrete thus has two characteristic traits. First, the students identify the 'kernel' as their mainstay to deduce particular features of the subject matter. Second, they strategically discover and reproduce the conditions of origination of the concepts they need to acquire. What this process means in terms of the school is that students reproduce the actual process whereby people have, over time, created concepts, images, values and norms that make for collective understandings within society (Engeström, 1996).

Davydov (1996) distinguishes six learning actions that follow the logic of ascending from the abstract to the concrete:

1. Transforming the conditions of the task in order to reveal the universal relationship of the object under study
2. Modelling the unidentified relationship in an item-specific, graphic or literal form

3. Transforming the model of relationship in order to study its properties in their 'pure guise'
4. Constructing a system of particular tasks that are resolved by a general mode
5. Monitoring the performances of the preceding actions
6. Evaluating the assimilation of the general mode that results from resolving the given learning task.

Davydov's theory suggests that many misconceptions students have about key learning concepts are due to the empiricist, descriptive and classification of traditional teaching and curriculum design. Knowledge gained at school often fails to become a 'living instrumentality' for making sense in the complex real world (natural and social), and so school knowledge is inert. This is because children do not have opportunity to discover 'kernels'. Nor do they get a chance to use the 'kernels' to deduce, explain, predict, and master in a practical way. However, according to Davydov, when the learning process is organised differently, children's thinking and understanding can be improved considerably. Davydov (1996) illustrates this point by stating his finding that many secondary school students explain the phases of the moon in terms of Earth's shadow, but then begin to question that understanding when asked about a lunar eclipse. Davydov believes these misconceptions have come about through commonly used abstract ideas and diagrams. What he suggests is a more constructivist approach where students interact with and actively discover 'kernels' for themselves.

I believe the idea of Davydov's 'kernels' is similar to Murdoch and Hornsby's (2003) definition of 'concept'. They write, 'Concepts are ideas which synthesise and bring meaning to parts of knowledge. A concept groups related facts (specific data for which evidence exists). A concept can often be identified by words or simple phrases that classify, categorise and define a group of related facts'

(pp. 137–138). Their definition aligns with McCormick's (1997) discussion of 'know how' (procedural knowledge) and 'know that' (conceptual knowledge). Conceptual knowledge includes knowledge of facts, gained not in isolation but as part of an active process that includes enculturation. Conceptual knowledge can cause problems in technical activities because of a lack of knowledge transfer (Jones, 1996). As a number of commentators stress, transfer of knowledge involves the ability to learn in one area and apply that knowledge in another curriculum area, and is a vital component of technological practice (Compton & France, 2006; McCormick, 1997; Moreland, Jones, & Chambers, 2001).

The Immigrant Biscuit allows students to develop a clear concrete concept of a 'development company' and what it means to be part of such a company. One student at the end of the immigrant biscuit activity was heard to say 'I didn't realise how difficult and complex working within a company environment can be'. The activity is a time of discovery, students learn first-hand the importance of a collaborative approach, the importance of open clear communication and indeed the frustrations when this does not occur. They also discover how and when skills and knowledge combine. Through the team approach, they are able to produce something that is well beyond any individual's capability. During the activity, the 'teacher' is a constant presence in the room, facilitating learning by making links and questioning students about their practice and understanding. A very simple example of this is identifying students' understanding of the concept of 'biscuit'. In New Zealand a 'biscuit' is closer to the concept of the North American 'cookie', and the North American concept of 'biscuit' is more aligned to the New Zealand concept of 'scone'. Awareness of the difference between knowledges across a range of settings, cultures and disciplines requires technologists to debate, prioritise and use sophisticated

decision-making within their technological practice (Compton & France 2006).

E. Thinking Theory/Strategies

Edward de Bono (1992) is at the forefront of thinking-based strategies, and his means of developing, challenging and extending children's thinking are well-known. One of his best-known strategies is 'thinking hats', which encourages people to think from a range of perspectives or points of view. Here, six hats, each of a different colour, represents a different perspective, for example: white—what are the facts?, red—what do I feel about this?, green—what new possibilities are there?, blue—what thinking is needed?, black—judgements, what is wrong with this?, and yellow—what are the good points or benefits? In New Zealand primary classrooms de Bono's thinking hats are regularly used to engage children in higher level thinking. For this course the concept has been modified to encourage teacher-education students to think from two perspectives as they participate in both theoretical and practical sessions (see Figure 3). The need for this strategy was realised when a student, after completing an investigation into functionality for which the context was the potato-peeler, stated 'I would never use this activity in the classroom because I don't like potatoes.' He had completely missed the point of thinking as a teacher, of considering his students' learning needs in terms sound education theory and his future classroom practice.

The students are given an outline of the two Thinking Hats in the first session and encouraged to reflect on their technological practice and learning using both hats to demonstrate their ability to link their experiences to both theory and classroom practice. The 'Two Thinking Hats' strategy

Figure 2: Two 'thinking hats' of technology teacher education (adapted from de Bono's 'Six Thinking Hats', 1992)

Two Thinking Hats of Technology Teacher Education

Teacher (brown-associated with the technology curriculum in New Zealand)
Consider:

- What does this mean for me as a classroom teacher?
- What are the applications to the classroom?
- How can this be modified to meet my children's needs?
- What are the implications for me as a teacher?
- What does this mean for my planning and implementation of technology education
- How will this influence or change my classroom practice?
- How will this advantage the children I teach?
- How may this disadvantage the children I teach?
- How and why does this link to relevant theory?

Active Participant –Learner (orange - different from de Bono's colours and symbolises new light and skills)
Consider

- What knowledge (conceptual, procedural, technical or societal) do I already have?
- What are my strengths and what can I contribute?
- What don't I know and need to find out?
- How can I find out what I need to know?
- What skills have I learnt?
- What skills have I yet to learn?
- What am I afraid of?
- Why and how can I allay these fears?

is a useful tool that /guides students to link requirements and concepts of the *Technology in the New Zealand Curriculum*, theory of three models of technological practice and constructivist learning theory to individual technological practice and to their eventual classroom practice through engagement in in-depth reflections. The students record these reflections in their portfolio.

The following examples of students' reflections illustrate links between theory individual technological and classroom practice.

> ***Models of Technological Practice***
> *The Kimbell Model of Technological Practice [is evident]. The production team are using their reflective capability to create a biscuit that will be enjoyed by Korean taste buds … At every step we are asking ourselves, "Is this appropriate? Does it have good design qualities? Are people going to want to purchase our product by seeing the ad? How can we*

make it better?" (female student 1, 03N, Christchurch College of Education, 2003)

Critical Path

This was completed by our CEO. It is a great overview of the whole process and allows you to see where you are up to and how far you have to go. This is quite useful in the classroom for the children to be aware of the timeframes available. According to Gawith (2000), the technologists must organise their resources such as time. (female student 2, Yr 3 D, Christchurch College of Education, 2006)

Herringbone

I really like this timeline process, as it clearly displays what I need to do in order to complete my task with the rest of the company. The times are not as specific for this model, which gives the necessary scaffolding while allowing some flexibility. In a class situation, most children would understand the concept and be able to see what they need to do to contribute to the final outcome. (female student 1 , 01N, Christchurch College of Education, 2003)

Materials/ Resources/ Skills 'Clouds'(brainstorm)

This is a useful brainstorm to narrow down the vast range of resources and skills available to us. Gawith (2000) states that technologists need to organise materials and resources as well as the process. Pacey's (cited in Burns, 1997) model relates the skills and tools available to the restricted meaning of technology, the technical aspect of the process. I think this is useful to be aware of, amongst all the creativity that goes with this task. There are certain skills and resources that have to be used to achieve the desired *outcome. For children's understanding, it is important to think about the skills they need, and have, to complete the given task. It would need some guidance from the teacher to complete this brainstorm.* (female student 2, Yr 3 D Christchurch College of Education, 2006)

Planning and Construction

The first try of making the plastic insert for the box according to our plans failed as the cardboard box inserts collapsed in the vacuum former. We then had to change the resources and apply knowledge to the problem at hand. This is an excellent example of Kimbell's (1991, cited in Burns 1997) Reflective Active Capability Model of technological practice. (female student 2, Yr 3 D, Christchurch College of Education, 2006)

Classroom Applications

The value for me is in my turning this back to the classroom and my role as a technology teacher. I having a realistic situation, authentic context and technological area, I am able to see how this practice relates to the curriculum document and not just what I teach but an insight into how I will teach it. (Male Student 1, 01N, Christchurch College of Education, 2003)

CONCLUSION

This paper illustrates how the constructivist based theory in teacher education facilitates reflecting thinking and enables students' insight into teaching technology education in the primary classroom. Technology education in New Zealand is based on a holistic and practically based curriculum, which is ideally suited to socio-cultural constructivist approaches to teaching and learning. As such, technology teacher-education programmes need to teach student-teachers a range of constructivist approaches that they can bring to their own classrooms and technology. The immigrant biscuit activity facilitates this approach which enables students to think critically about technology and how it is best implemented.

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